Human-Machine Interface Research at the Los Alamos National Laboratory Engineering Institute

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Abstract— Since 2012 the Los Alamos National Laboratory's Engineering Institute (LANL-EI) has engaged in novel research in the area of human-machine interfaces. Initially the LANL-EI was interested in exploring the use of the sensory substitution phenomena to extend the human nervous system to cyberphysical systems such as infrastructure using haptic interfaces. The inspiration behind this idea was that machinists often setup their lathes and milling machines using the "sense-of-touch," so why could we not extend this idea to more large-scale structures and machinery featuring distributed sensor networks? In particular we decided to test the concept for structural health monitoring applications. The goal of the structural health monitoring community has traditionally been to endow infrastructure with a distributed sensor network that emulates the human nervous system, so there seemed to be a good fit between the two concepts. A vibro-haptic glove was developed to test the idea using an experimental model of a three-story structure generally used in the laboratory. In the initial results humans did a very good job of recognizing false positives which was a promising result because eliminating false-positives is quite important for structural health monitoring applications. Since that initial work the LANL-EI has expanded its human-machine interface work to a number of different areas. We have begun work to test whether human proprioception can be extended to robots with nonhuman kinematics. We have begun to look at ways that sensing and Virtual Reality/Augmented reality can be combined to make work in gloveboxes with nuclear materials more safe by providing additional information to technicians on criticality safety. We are exploring ways to extend the hands, eyes, and ears of structural inspectors using multirotors equipped with microphones, cameras, and tap-testing hammers. We have also developed a novel framework based on Jungian Psychology for artificial personality synthesis. Going forward we also hope to extend this work to building new human-machine interfaces for infrasound networks. A general overview of LANL-EI work on human-machine interfaces will be presented.

Keywords—haptics; sensory substitution; criticality safety; structural health monitoring; nocioception; proprioception